

Importance of high-resolution modeling for storm surge, hurricane waves, and coastal water levels and currents in Puerto Rico and the U.S. Virgin Islands

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As part of the SURA/IOOS COMT II the ADCIRC and ADCIRC+SWAN models have been used for the simulation of tides, currents, water levels, storm surge, and hurricane waves under a range of conditions including purely-tidally forcing, tide-atmospheric forcing, and parametric hurricane wind forcing. A high resolution unstructured mesh, with a spatial resolution of at least 100 m along all the coastlines of Puerto Rico and the Virgin Islands, has been used for these simulations. This mesh provides a very accurate representation of the irregular coastlines of the region, the steep bathymetric gradients, and coastal features such as reef systems and shoals which affect the coastal dynamics and the breaking of waves during both hurricanes and winter swell events. Results of both ADCIRC and ADCIRC+SWAN simulations show very good agreement with observations of tidal harmonic constituents, water levels, storm surge, and wave parameters. In addition the results show that the high resolution of the model allows for the generation of non-linear effects such as high-frequency water level oscillations and seiche modes. Moreover the coupling of the tide and atmospheric forcing during non-cyclone conditions has shown that atmospheric forcing is a necessary condition for the generation of coastal currents in Puerto Rico and the U.S. Virgin Islands.

Blocking and dissipative effects of the reef and shelf geometries generate very localized wave breaking and water level distribution and patterns during hurricane forcing, which would be of great benefit for NOAA if incorporated into the storm surge modeling systems. The inclusion of these simulations and the validation data in the COMT II database will allow for the distribution and easy accessibility of results by the scientific community and government agencies, particularly through the visualization infrastructure being built as part of the COMT.